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# *Pascal*

## A Mars Climate Network Mission

Anthony Colaprete,  
Bob Haberle,  
and the Pascal Team



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# Pascal Team

Principal Investigator: Bob Haberle, ARC

Deputy PI: Aaron Zent, ARC

- US Co-I's:

- Conway Leovy, UW
- David Catling, UW
- Tim Schofield, JPL
- Dave Atkinson, UI
- Jim Murphy, NMSU
- Chris Webster, JPL
- Peter Smith, UA
- Anthony Colaprete, ARC
- Ron Greeley, ASU
- Jeff Barnes, OSU
- Jill Bauman, ARC

- International Co-I's:

- Jean-Pierre Pommereau, SA
- Pascal Rannou, SA
- Francois Forget, LMD
- Frederic Hourdin, LMD
- Oliver Talagrand, LMD
- Ari Matti Hari, FMI

- Industry Partners:

- Ball Aerospace (Prime)
- LMATC (Surface Station)
- Aerotherm (Entry System)

- Mission Management:

- JPL





# Science Objectives

**(1) Joint characterization of the near-surface general circulation and its interaction with the surface.**

- Measure the surface signature of the general circulation
- Monitor aeolian processes & water exchange

**(2) Determine how the general circulation controls the dust, water, and CO<sub>2</sub> cycles**

**(3) Provide a basis for comparative planetary meteorology**

**(4) Provide a weather monitoring infrastructure for future missions and synergy for all observations**

***==> Characterize the Present Global Climate System <==***



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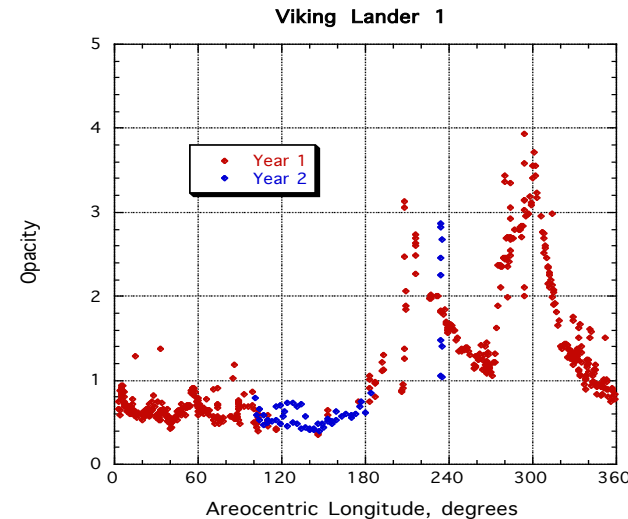
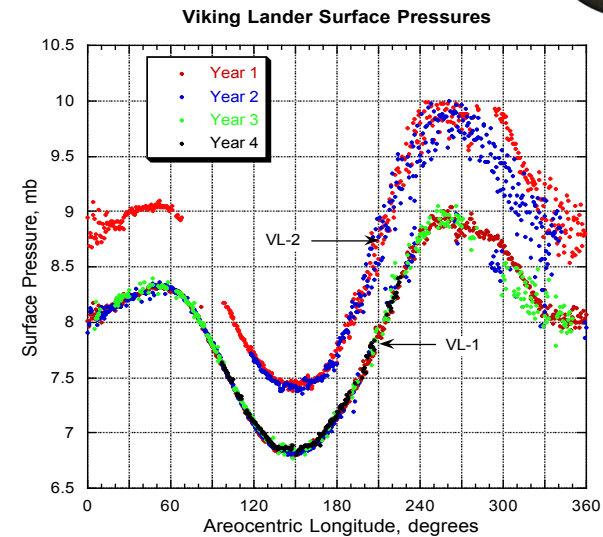
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## *Pressure and Opacity Are the Most Important Measurements*

- Pressure gives column mass
  - *Pressure gradients related to winds*
- Opacity gives the forcing
  - *Measures extinction of solar radiation*
- The combination also gives
  - CO<sub>2</sub> cycle
  - Dust cycle

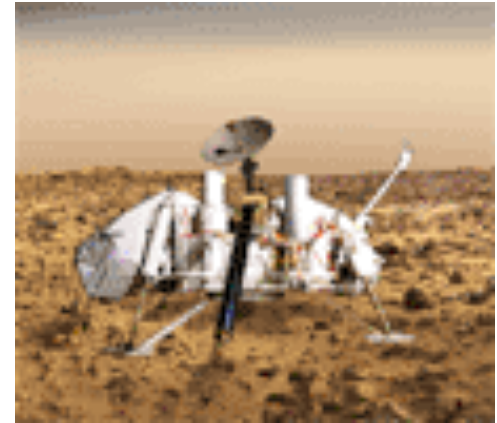




# Mission Design Philosophy

## *Capable landers:*

- Address multiple disciplines
- Become heavy and expensive
- Cannot deliver enough landers

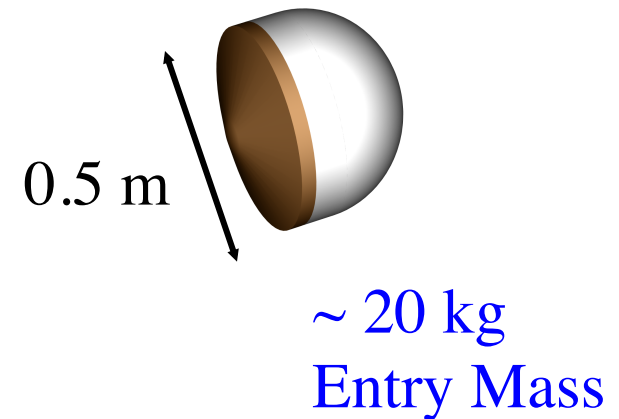


## *Tradeoff:*

- Instead of many measurements at a few sites
- Make a few measurements at many sites

## *Focus payload on key measurements:*

- Pressure and Opacity
- Then enhance the science as resources permit





## How Many Stations are Needed?

General Circulation

- **Need broad latitudinal coverage**
  - sample each meteorological regime
    - 1 in tropics
    - 1 in mid-latitudes of each hemisphere
    - 1 in polar regions of each hemisphere
- **Need to resolve longitudinal structure**
  - wave 2 is dominant feature
  - need *at least* 4 stations  $\sim 90^\circ$  apart
- **Don't need many polar stations**

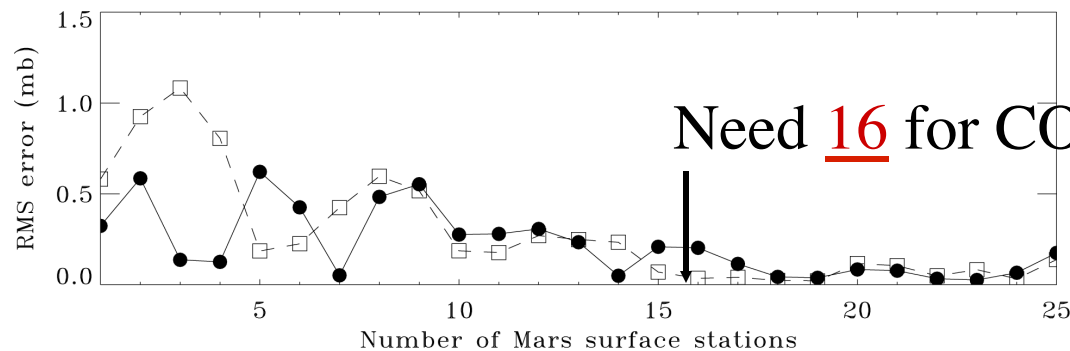
No. Stations

5

$5 \times 4 = 20$

$20 - 4 = \underline{16}$

CO<sub>2</sub> Cycle



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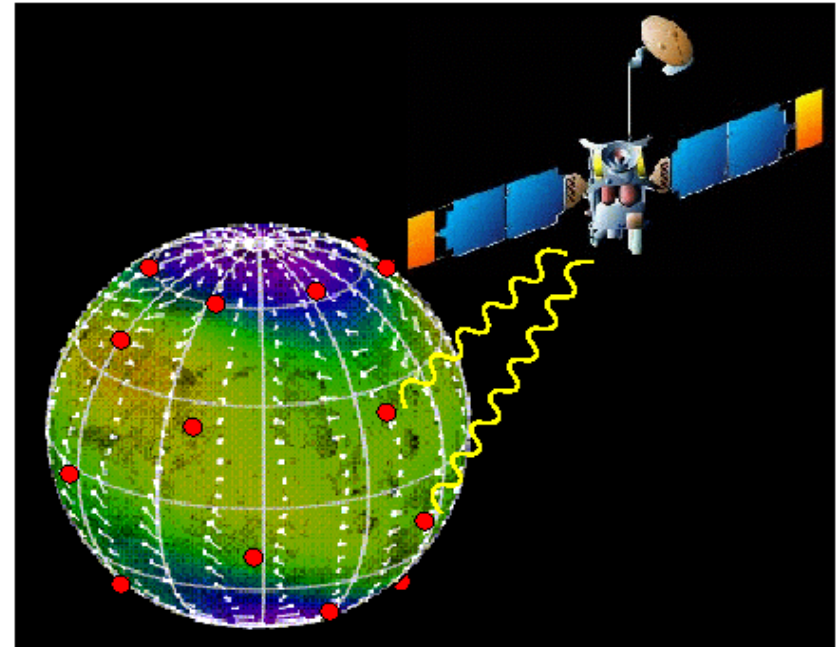
# The Pascal Mission

Global network of 18 weather stations

Stations operate for 3 Mars years

Landed measurements:

- pressure (hourly)
- opacity (hourly)
- temperature (every 15 minutes)
- wind speed (every 15 minutes)
- water vapor (twice per sol)
- B&W panoramic images (1/Mars Mo)



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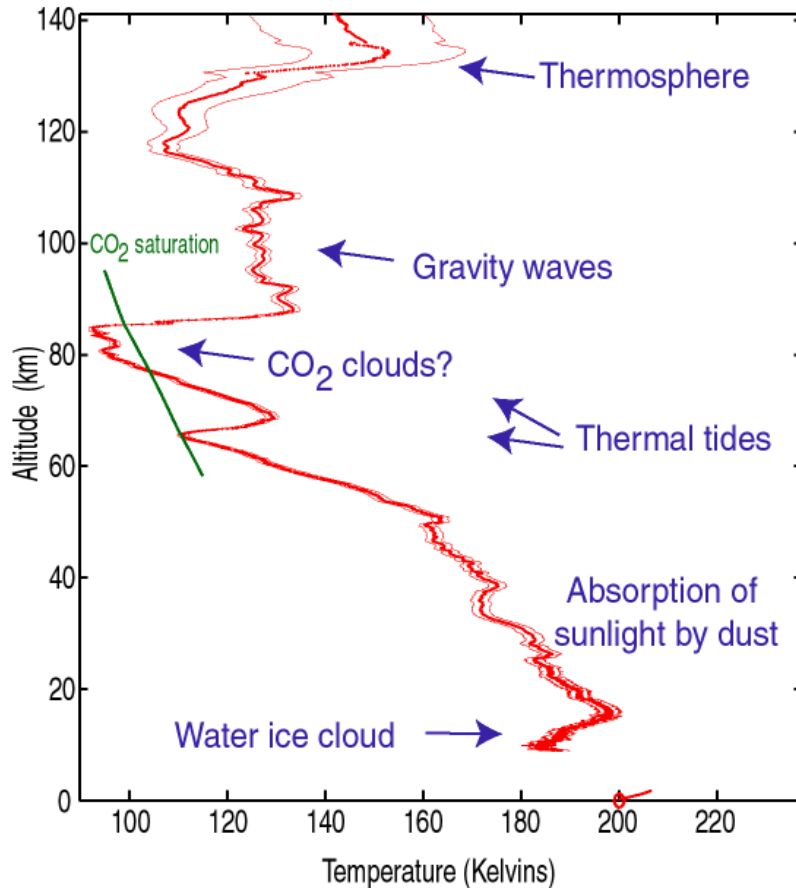






## Pascal EDL Measurements

### Atmospheric Processes in Pathfinder ASI Profile



### Entry Science

- 18 T-profiles
- 10-80 km
- Global
- Late AM/PM local times

### Descent Imaging

- ~ 10 images
- Res: >30 cm/pix



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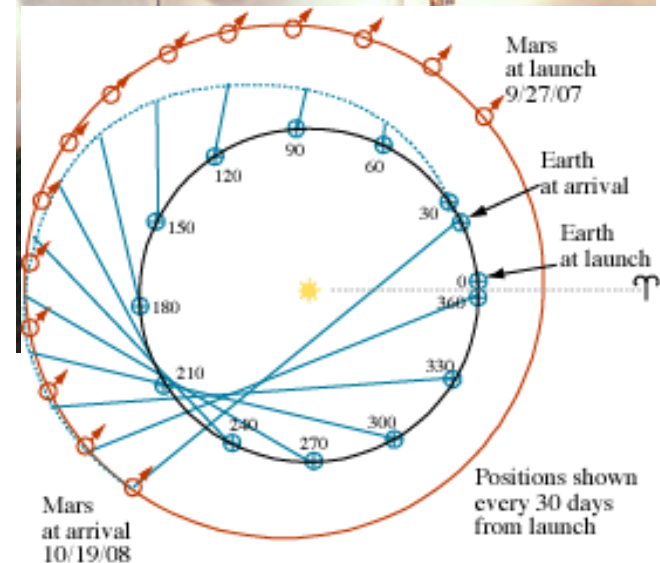






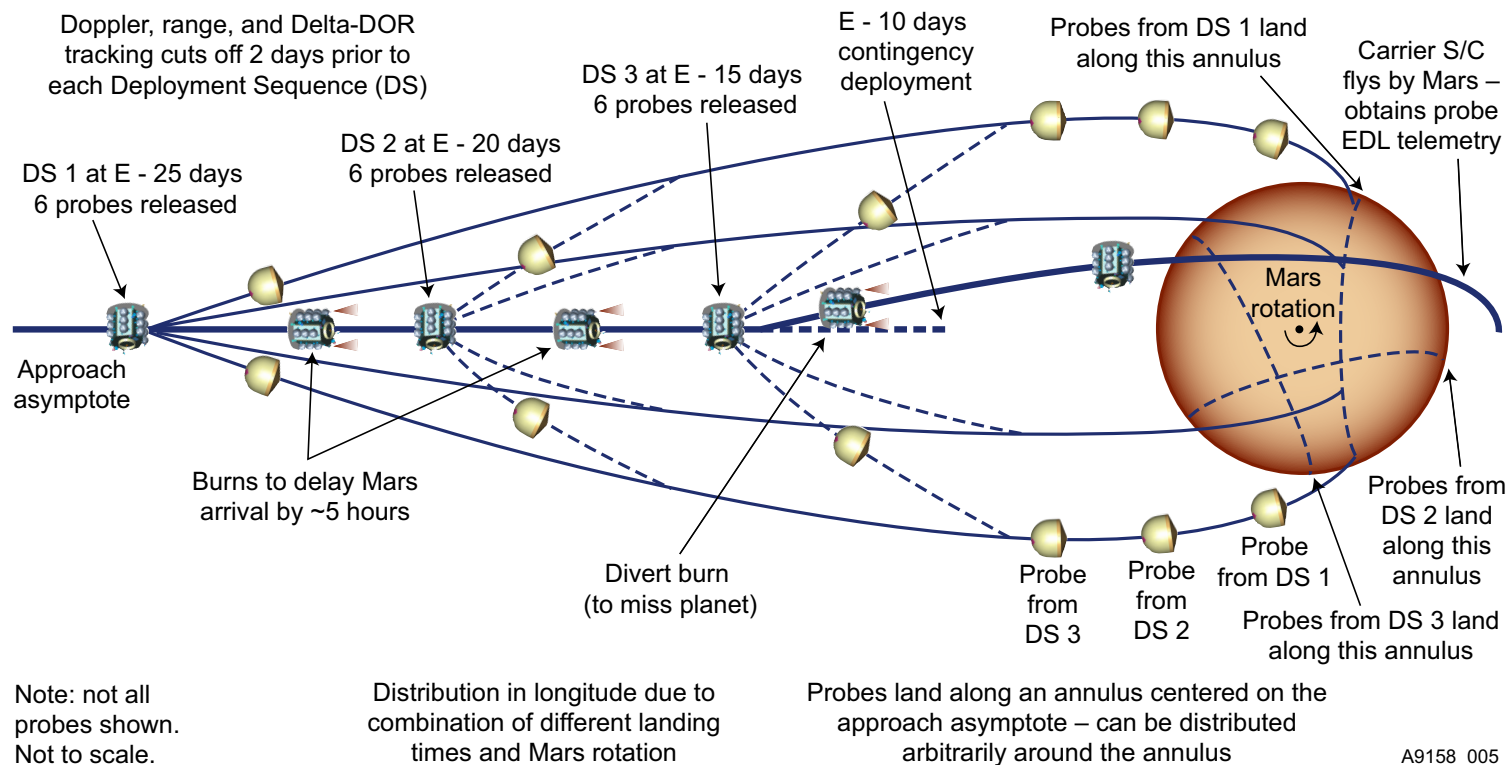
# Mission Concept

- **Launch:** 9/27/07 (20 day window)
  - Delta III-3940
  - Type II trajectory
- **Mars arrival:** 10/19/08 ( $L_s=146^\circ$ )
  - Release probes on approach
- **Probe entry, descent, and landing:**
  - Aeroshell, Parachute, Air bags
  - Entry data stored for later transmission
  - No communication during EDL
- **Autonomous surface ops:** 3 Mars years
- **Station power:**
  - Milli-watt Power Generator (MPG)
- **Communication:**
  - MEP Orbiters
  - Mars Express
  - Others?

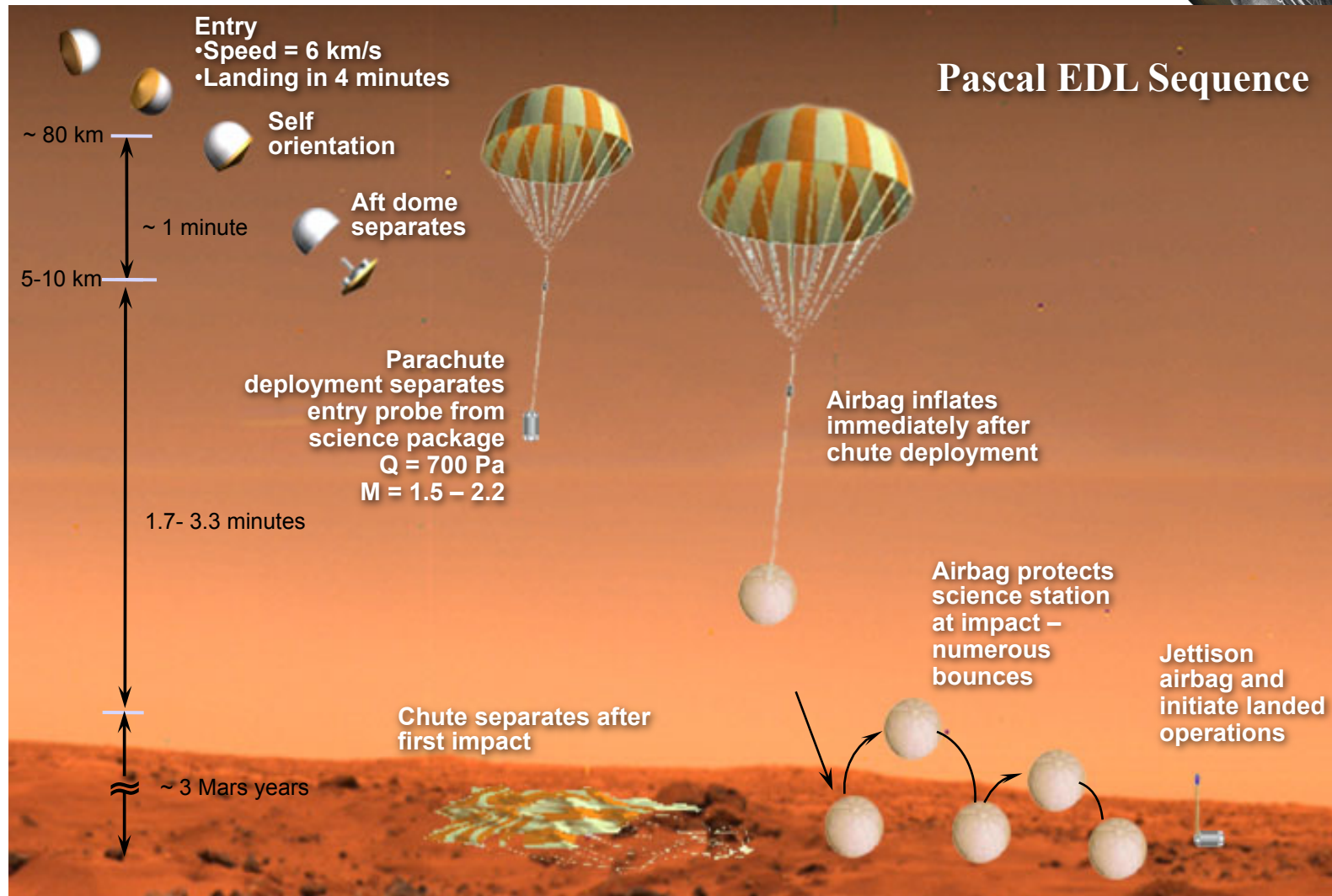




## Pascal Probe Deployment Sequence



# **Pascal** A Mars Climate Network Mission



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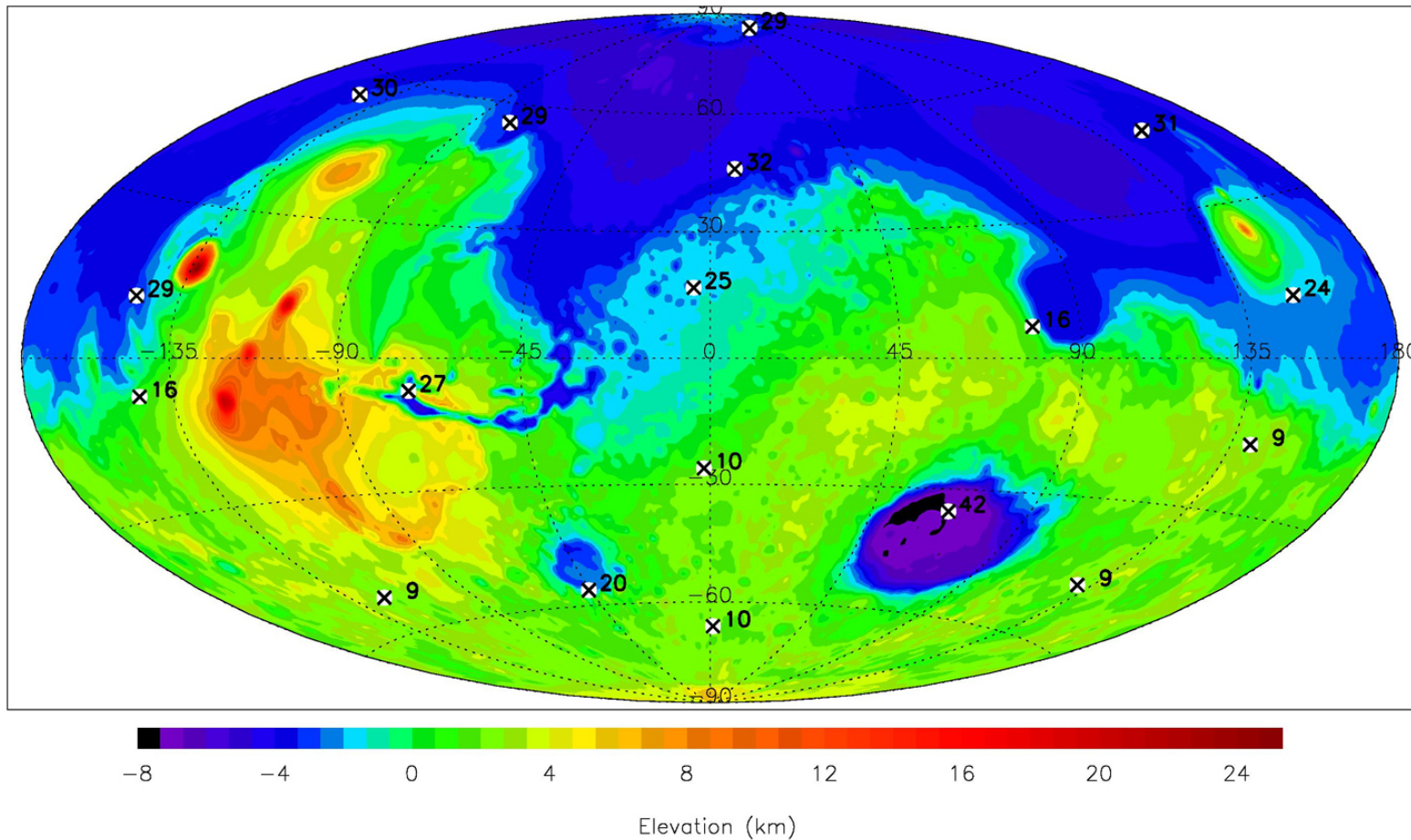


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## *Sample Network Configuration*



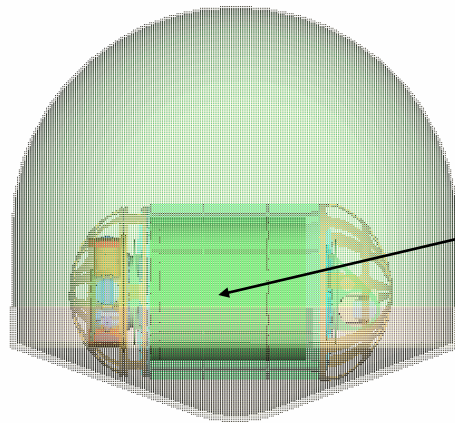
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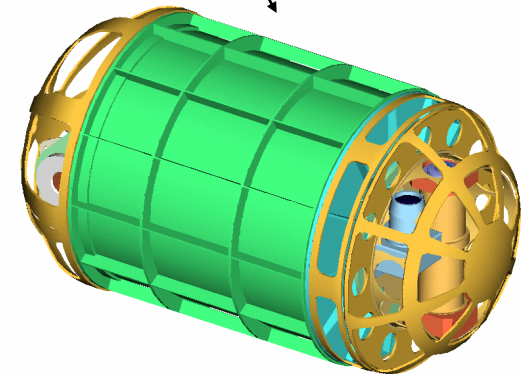


## Probe Entry System



0.5 m

Science Station



- 70° half angle cone
- Hemispherical backshell
- 20 kg entry mass





## *The NASA Ames GCM & Probes*

Excellent tool to plan EDL:

- Winds
- Atmospheric density

Provides BC's for Mesoscale Models:

- Dan Taylor (MM5)
- Scot Rafkin (MRAMS)

Pascal would provide the BEST validation of the GCM



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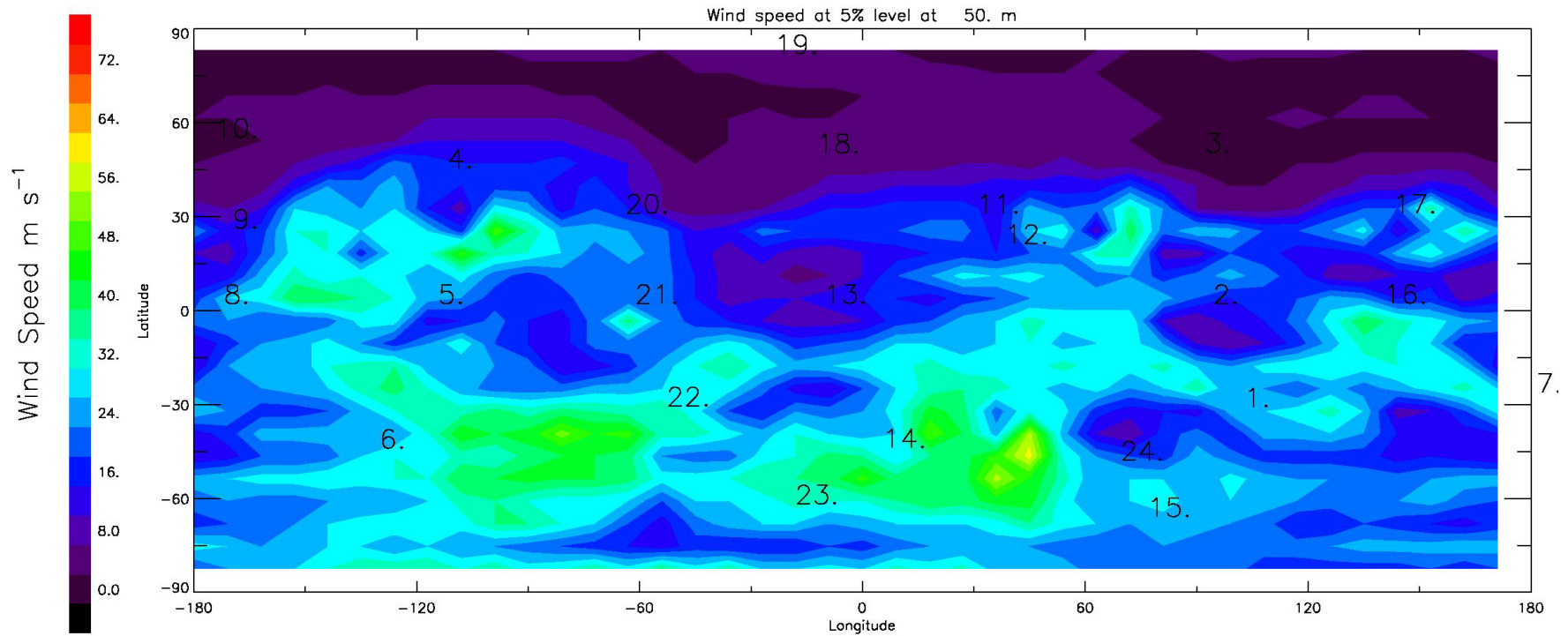


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## Predicted $3\sigma$ Winds at $z = 50$ m for $L_s = 140$



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## *Pascal Future*

- Next Scout opportunity scheduled for 2011
- Much development work is needed
  - Power Source
  - Science Station
  - EDL system
  - Instrument prototypes
- Funding the development effort will be difficult
  - No single source
- Pascal's future is very uncertain

